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Fireballs in the Sky: Citizen Science with the Desert Fireball Network

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Abstract

Fireballs in the Sky is an innovative Australian citizen science program that connects the public with the research of the Desert Fireball Network (DFN). This research aims to understand the early workings of the solar system, and Fireballs in the Sky invites people around the world to learn about this science, contributing fireball sightings via a user-friendly augmented reality mobile app. Tens of thousands of people have downloaded the app world-wide and participated in the science of meteoritics. The Fireballs in the Sky app allows users to get involved with the Desert Fireball Network research, supplementing DFN observations and providing enhanced coverage by reporting their own meteor sightings to DFN scientists. Fireballs in the Sky reports are used to track the trajectories of meteors – from their orbit in space to where they might have landed on Earth. This presentation will provide an overview of the DFN and will focus on the Fireballs in the Sky citizen science component.

1. The Desert Fireball Network

The DFN uses automated observatories across Australia to triangulate trajectories of meteorites entering the atmosphere, determine pre-entry orbits, and pinpoint their fall positions. Meteorites with a known pre-atmospheric entry orbit can allow us to constrain the origin of the rock in the main asteroid belt, and possibly in some cases, even the specific asteroid parent body. The citizen science component provides expanded observations and data. Expansion of the network to international locations beyond Australia is now underway to build a Global Fireball Observatory (GFO). The expectation is that the Fireballs in the Sky initiative will be expanded to meet the needs of international partners. The DFN is a collaborative effort NASA SSERVI (Ames) and Curtin University in Western Australia. It is led by Phil Bland of Curtin University.

2. Observatory Design and Network

The observatories are fully autonomous intelligent imaging systems, capable of operating for 12 months in a harsh environment without maintenance, and storing all imagery collected over that period. Each observatory uses a 36MP consumer DSLR camera equipped with a fisheye lens providing spatial precision of approximately one arcminute. The DSLR is modified with a liquid crystal (LC) shutter. The LC shutter is used to break the fire-ball trail into dashes for velocity calculation, after triangulation. The LC shutter implementation allows the fireball's arrival time to be encoded by modulating the dash length according to a De Bruijn Sequence [1] synchronized with GPS time, yielding sub-millisecond timing precision. A video camera provides additional imagery of the fireballs - especially of fragmentation events. Observatory control and autonomy is implemented with an onboard low power consumption PC with a system drive, power supplies, GNSS module, microcontroller, and shutter driver.

The Australian network currently consists of 52 observatories covering more than 3 million km^2 of the Australian Outback. As a part of the event detection, the observatories communicate with the network's central server via an internet connection (where available) to corroborate potential fireball events with a preliminary approximate tri-angulation excluding single station false positives. Centralized tasks within the network include extraction of data points, decoding of timing, multi-station triangulation, trajectory analysis, mass estimation, atmospheric simulation, dark flight modeling, orbit calculation, and orbit back propagation.

Through a variety of partnerships including with NASA's Solar System Exploration Virtual Institute,

the DFN is expanding beyond the Australian Outback to international locations around the world. This includes establishing networks with international partners, as well as expanding the global user base of the Fireballs app. Institutions that are interested in joining the GFO initiative, as well as making observations and coordinating recovery efforts for fireballs in their areas, are invited to contact the authors for more information.

3. Results

The network has recovered four meteorites with orbits: Bunburra Rockhole, an anomalous basaltic meteorite [2] in 2008; Mason Gully, an H5 ordinary chondrite [3, 4] in 2010; Murrili, an H5/S1 ordinary chondrite in 2015; and Dingle Dell, a chondrite recovered near Morawa in 2016 [6]. The recent recovery of the Creston meteorite by the SETI GFO partner demonstrates how the GFO collaboration will work.

4. Citizen Science with Fireballs in the Sky

Fireballs in the Sky is an award-winning citizen science program that connects the public with the research of the DFN. Citizen Scientists using DFN's free Fireballs in the Sky app for Android and iOS can extend and enhance observations of the DFN by submitting their own observations. Through augmented reality, an intuitive interface and sensing technology of this smartphone app, anyone anywhere in the world can recreate their fireball sighting to contribute scientifically useful data. Users of the app can:

• Pinpoint the altitude and azimuth of the start and end of the fireball you saw

• Select different options for duration, shape, brightness, color and hue, and watch how an animated fireball changes to match what they've just seen. If it looked like it fragmented as it came through the atmosphere, users can select different options for number of fragments, and see the animation change accordingly.

• Add any other notes or details to their sighting report.

• Keep track of their sightings, and those of other users.

• Get updates on their sightings, and see levels of detail in feedback: Was it seen by other users? If it was, then how many other users saw it? Was there enough information to work out a trajectory? What was its orbit: where did it come from in the solar system?

• Find out when and where in the sky meteor showers are occurring, using the augmented reality heads-up display

• Get fireball news, and see updates on the DFN project, announcements and events

• Access the GFN's gallery of zoomable images – the fireballs the network seen and the meteorites that the project has found.

The Fireballs in the Sky Teacher Resource Book provides experiments and activity ideas to supplement classroom science and math teaching around the theme of 'Fireballs in the Sky'. Experiments can be used individually or as the whole unit to engage students in science and math.

Renae Sayers, Planetary Science Outreach Officer at Curtin University, coordinates Fireballs in the Sky.

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